What is "basic ASHRAE water chemistry"?

The ASHRAE water chemistry requirement is from "Liquid Cooling Guidelines for Datacom Equipment Centers", Second Edition, 2014, ISBN 978-1-936504-67-1, also designated ASHRAE-D-90564. See Table 5.3, Water Quality Specifications for Facility Water System (FWS) Loop, which is reproduced here:

Parameter	Recommended Limits
pH	7 to 9
Corrosion inhibitor	Required
Sulfides	<10 ppm
Sulfate	<100 ppm
Chloride	<50 ppm
Bacteria	<1000 CFU/mL
Total hardness (as $CaCO_3$)	<200 ppm
Residue after evaporation	<500 ppm
Turbidity	<20 NTU (nephelometric)

Are there any additional requirements, for example, for filtration?

ASHRAE does not specify any additional parameters, such as conductivity, total suspended solids, mineral content, or filtration. Since you asked, NERSC uses a 20 mesh strainer and LANL uses a 40 mesh strainer. Finer mesh strainers are not desirable but might be possible as long as the increased pressure drop at the required flow rate is within design capabilities, or implemented as a side-stream filter.

What should we do if our water chemistry requirements are different?

If your requirements differ (either more or less restrictive), please provide your alternative specifications.

Both NERSC and LANL use black (carbon) steel pipe for the FWS loop delivering cooling water to the system. Additional wetted materials include rubber, copper, stainless steel, etc. Some variation from the specifications can be tolerated with adjustments to chemical additives. If your requirements are inconsistent with our current infrastructure, it would be necessary to modify our infrastructure, for example to install a tertiary water distribution loop with a heat exchanger as an interface to the current FWS.

ASHRAE guidelines describe the presence of contaminants but not the presence of preventive chemicals such as fungicides or anti-corrosives. Could you tell us if you use any such chemicals?

Both sites use corrosion inhibitors and biocides, but the chemicals may differ. ASHRAE water chemistry is maintained by monitoring FWS loop water and making water chemistry adjustments as needed. Coupon stations monitor corrosion of selected materials.

What about condensation?

By design, coolant pipe temperatures will be above the dew point at all times.

The text says "If a tertiary loop is included", not "If a tertiary loop is required". Which is it?

If the system water chemistry requirements cannot be met with our current infrastructure (and simple adjustment to chemicals), it is our requirement that the vendor provide a tertiary water distribution system as part of a packaged solution (e.g. a cooling distribution unit and internal piping). This will best ensure the proper operation of the system, and eliminate any “finger pointing” regarding water chemistry.

The draft technical specification says "All coolant loops within the system shall have reliable leak detection, temperature, and flow alarms, with automatic protection and notification mechanisms." Are we correct in that this is referring to tertiary loops that we require? That is, if we are using facility water flowing through some rack heat exchanger, then we do not need to provide leak detectors, automatic shutoffs, etc.

This refers to any coolant loops present in the system you propose. Even if the facility water could be used directly in the system without a tertiary loop, the intent of our requirement is that the system be able to protect itself against internal leaks that could damage the system. Note that section 5.6.3 makes it the responsibility of the vendor to correct damage resulting from a leak in piping provided by the vendor.

Re 5.6.3, “Hardware failures due to environmental changes in facility power and cooling systems which can be reasonably anticipated (such as brown-outs, voltage-spikes or cooling system failures) are the responsibility of the successful Offeror.” Does a lightning strike count as something that can be reasonably anticipated?

The intent of 5.6.3 is to clarify what repairs are the responsibilities of the vendor and what is the responsibility of the Laboratories in regards to environmental failures. The Laboratories desire to minimize their liability regarding systemic failures, including acts of nature. The more a system can protect itself, or the more inclusive the coverage of a maintenance contract, the better.

Facility and site-wide lightning protection is available but some transients will inevitably reach all connected equipment despite capable grounding and facility level transient voltage surge suppression (TVSS). Table 3, in section 3.11.4, addresses the specific requirement for power quality and surge protection. Systems are required to meet or exceed the ITIC power quality curve specification, which require surviving brief voltage transients of at least 500% the nominal voltage. Offerors should describe any surge protection capabilities beyond this specification.

Can you provide more background/guidance regarding "Maximum Power Rate of Change"?

In general, this is an immediate requirement for Crossroads, but it is quite possible that a similar requirement may emerge for NERSC-9 during its lifetime.

We need to provide to our utilities a schedule of expected hourly power averages at least 24 hours in advance, and track this prediction within +/- 1 MW (or provide 2 hr notification of change), otherwise costs of electricity go up. Our expectation is that this should be easily accomplished, since the platform will be 80-90% utilized at most times while in production. This means that the most important power changes, at the hourly average basis, will be when the platform is taken out of service for maintenance or shut down. Section 3.10 Power and Energy also asks for power ramp rate limiting capabilities, but does not define specific targets, instead, the expectation is that the vendor will characterize provided ramp rate limiting capabilities. The intent of that requirement is to support future power contract negotiations, by providing tools to avoid electricity price increases.

Maximum power rate of change requirements for Crossroads are explained in Table 3, based on hourly power averages. The LANL power contract is based on purchasing hourly electricity blocks in advance, then following this power schedule within +/- 1 MW tolerance. LANL needs to provide this schedule at least 24 hours in advance for best electricity pricing. If there are changes known at least 2 hours in advance, adjustments can be made by trading power blocks on the spot market. Note that this is based on hourly billing interval average, not on instantaneous power demand. If our power use falls below the lower limit, we pay for unused electricity. If it goes above the upper limit, we must pay emergency power rates, and worse yet, we may increase our demand charge (that may cost us 300 times more than normal, if the demand is increased during the worst hour of the month).

There are several reasons for limiting power ramp rates, based on control bandwidths of several supporting systems. On the time scale of AC cycles to hours, the concern is about the power grid's ability to adapt to changed power levels when operating under stress from another simultaneous power event. On the time scale of minutes, the concern is about the cooling system adapting to changes in cooling demand. On the time scale of minutes to hours, another concern is about the time it takes to bring cooling towers (or chillers) into or out of operation. Violating control bandwidth constraints of supporting

systems creates difficulties that utilities may price into our power contract, as well as operational difficulties that may require unreasonable control effort on the facility side. If it necessary to burn power to limit ramp rates, the duration should controlled by the ramp rate limit.

Is there any possibility of connecting APEX system power and infrastructure (e.g. cooling) power to share information to optimize each?

For Crossroads, Facility and platform reside in different security domains; information sharing would require special security approvals. For NERSC-9, this is potentially possible.